the best beginning. I believe that, on the contrary, unless the demonstrative and deductive principles of the science are soon introduced to the student's notice, he is likely to acquire a distaste for the subject.

I was learning, under an infliction of practical geometry (at school), to detest the very sight of a box of mathematical instruments, when a fortunate illness kept me at home for two or three years. I believe that Euclid, as it would have been introduced to me at school, would have rendered my dislike for mathematics complete. But becoming possessed of a Simson's "Euclid," and *reading* it instead of learning it for "class," I found geometry the most enjoyable of subjects. In a very few months I came to the end of the book, and I have never lost the liking for geometry which I had by that time acquired.

Let it not be supposed, however, that I advocate the claims of Euclid as a text-book. The first, third, and sixth books might indeed be retained—with certain omissions and modifications; but the second and fourth books (setting aside a few propositions) are monstrosities of clumsiness.* The fifth, eleventh, and twelfth could never be generally used in their present form. But whether a totally new text-book be adopted or Euclid be modified, I am convinced that until the demonstrative and deductive nature of the science is recognised the interest of the student will not be excited.

While, however, my own experience will not permit me to believe that a course of practical constructions is a suitable introduction to geometry, I certainly agree with Mr. Wilson in regarding careful constructions as of the utmost importance to the learner. But, in my judgment, the processes of construction should accompany, not precede, the study of some demonstrative and deductive treatise.

I believe the chief difficulty under which we labour at present, resides in the fact that, owing to the small encouragement given to the study of geometry at our Universities, we have, even among our ablest mathematicians, very few able geometricians. One cannot read the Cambridge text-books of mathematics—written though these are, in many instances, with singular ability—without becoming convinced of this. So soon as a geometrical construction is introduced we recognise the clearest traces of inaptitude. The fact is still more clearly evidenced in treatises professedly geometrical. I take up an edition of Euclid, prepared by a very eminent mathematician, a senior wrangler, and, opening at random the portion relating to deductions, I find the following problem:—"Required to draw a circle through a given point to touch two intersecting lines;" and to solve this obvious third-book problem the aid of the sixth book is called in.

But it is hardly to be wondered at that university mathematicians are, as a rule, not strong in geometry, for the study of geometry is very little encouraged by university tutors. Indeed, an aptitude for geometrical methods is generally regarded as more mischievous than useful in the Tripos. I can remember the hints I myself received on this point. A few instances may perhaps interest your readers.

The first hint was given me in the lecture-room by a high wrangler (an excellent geometrician). The following proposition had been submitted—"A ball is placed on a horizontal plane, above which is a luminous point; show that the length of the minor axis of the ball's elliptic shadow depends only on the height of the luminous point above the plane." I wrote for answer that the fact is obvious, because two sloping planes touching the ball, and with a horizontal intersection through the luminous point, must clearly have the same slope wherever the ball is placed. The proof was accepted, and even regarded (to my infinite surprise) as ingenious; but I was warned not to leave the safe track of analysis.

The next hint was given me by my private tutor, a senior wrangler with fine (but untrained) geometrical powers, on the score of my solving geometrically some problems relating to epicycloidal and hypercycloidal areas.

The third hint was given me by a vacation tutor, also a senior wrangler, and was perhaps the best deserved of the three. He had set me a problem relating to a curve which chanced to be a projection of the four-pointed hypercycloid, and the problem was meant as an exercise in analytical processes. Knowing very little about these, I ventured to proceed *more meo*. I first projected the curve back again (so to speak), established the property in the case of the quadricuspid hypercycloid, and reprojected all my constructions on the original plane of the curve. I shall never forget the solemnity of the warning I received.

The last case I shall refer to relates to a probability problem (the last in Todhunter's "Integral Calculus") about a messenger and a shower of rain, the messenger's "expectation" under certain stated conditions being expressed in the following pleasing form:—

$$\frac{v}{n}\left\{\frac{1}{2}-\frac{u}{v}+\frac{u\,(u+v)}{v^2}\log\frac{u+v}{u}\right\}$$

From the day that I gave a geometrical solution of this problem (the logarithm coming out as a hyperbolic area) I was given up as a bad job. No wonder, indeed, for as a problem in the Integral Calculus it can be solved in half-a-dozen lines.

So little encouragement is given to geometrical work, that I know instances where men who have taken very high degrees could not solve the easiest geometrical problems. Many indeed in my time (I believe Mr. Wilson would confirm this) in their second or third year at Cambridge, scarcely know what has to be done with such problems—that is, even how to try to solve them. I wrote a little pamphlet four or five years ago, to show how such problems should be attacked, proceeding on the following plan:—I took the case of a beginner dealing with easy geometrical problems, and considered his difficulties and false steps, as well as the true demonstration ultimately evolved. I did this because I had found it the only effectual course with pupils. To give problems, and on the pupil failing to solve them, to show him the solution, is utterly useless. One must listen to his reasoning, wrong or right, to the purpose or not—show him why it is wrong, or not effective towards the solution of the problem; and so gradually guide him towards the correct solution. In the pamphlet I employed a corresponding method.

Unfortunately (for me at any rate) Messrs. Longmans submitted this pamphlet to "a competent mathematician," who immediately misunderstood my plan; took the imagined difficulties for real difficulties of my own, and solved for my behoof an immensely difficult problem—the first worked-out example in Potts's Euclid. This achievement (*par parenthèse* my pamphlet also) was then submitted to another competent mathematician, and he, excited to emulation, suggested another solution of a problem which a boy of twelve might safely attack. Finally, these labours were submitted to Messrs. Longmans and (signatures removed) to myself. So my pamphlet has remained in my desk; for I thought better of it than to send it begging.

We want geometricians more than text-books just now. If our universities would give geometry a reasonable position among the subjects for mathematical examination, we should probably soon have both. At present a man with geometrical tastes must either turn from his favourite subject during his university career (with small chance, perhaps, of resuming it) or must be content with but a small share of university success.

Brighton, September 15 R. A. PROCTOR

Captain Sladen's Expedition

IN reply to F.R.S.'s inquiry in your issue of September 14, I may state that the last number of the "Proceedings of the Zoological Society of London" (1871, part 1) contains several articles by Dr. John Anderson relating to discoveries made during Capt. Sladen's expedition to Yunan, and that the next number (1871, part 2), which I am now preparing for the press, will contain others.

It was Dr. *Thomas* Anderson, Curator of the Botanic Garden at Calcutta, whose untimely death we have recently to lament. Dr. *John* Anderson (his brother) is, I am happy to say, in good health at his official post as Curator of the Indian Museum and Professor of Comparative Anatomy at Calcutta, or was so, at all events, at the date of his last letters to me, about a month since.

11, Hanover Square, Sept 16 P. L. SCLATER

Deschanel's Physics

As regards the particular passage in my edition of Deschanel which I am challenged to defend by your Reviewer (NATURE, vol. iii. p. 343), his charge, which is somewhat obscured by rhetorical embellishment, seems to be that in the factor $\frac{H-h}{760}$ it has not been indicated that H and h, as well as 760, denote so many millimetres of mercury *at zero*. I think this was scarcely necessary, as the question whether the observed or reduced heights of the mercurial columns should be employed, is not one on which

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* All the propositions of Book II, save four, may be established (usually) in three lines from the first two, of which they are in fact little more than corollaries. The main objection to the fourth book relates to the inscription and circumscription of the regular figures; but throughout the book the heaviness of Euclid's method is much felt.

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a doubt could occur to the mind of any intelligent reader, reduced heights being invariably employed in the chapter in which the passage occurs, and in the book generally.

The charge of inconsistency which the Reviewer urges with so much gusto, is based on the following passage in my Preface, at the beginning of Part I :—

"There is great danger in the present day lest science-teaching should degenerate into the accumulation of disconnected facts and unexplained formulæ, which burden the memory without cultivating the understanding. Prof. Deschanel has been eminently successful in exhibiting facts in their mutual connection ; and his applications of algebra are always judicious."

Which, the Reviewer thinks, justified the expectation that I would omit as many as possible of Deschanel's applications of Algebra. It is not surprising that a writer accustomed to this style of inference should have an aversion to exact reasoning, and should characterise the solution of problems by the application of a little algebra as "intricate formulæ, which burden the memory without cultivating the understanding."

I may remark, with reference to my former discussion with W. M. W. in your pages, that the adoption of concrete units of mass, and derived units of force, has now received the official sanction of Sections A and G of the British Association, who have appointed a committee to frame a system of nomenclature on this basis. J. D. EVERETT

Newspaper Science

KNOCKED up with work, I reluctantly followed the advice of my medical man, and crossing the Channel so as to be more out of the way, resolved to eschew everything scientific for the next few weeks at least, in order to recruit before the winter's labours commenced. Even here, however, I soon found that the desired result was not so easily attainable as I had imagined, for the first thing this morning, on entering the reading room of the bathing saloon, a French acquaintance, placing the *Globe* (of Monday evening, September 11) before me, directed my attention to its leading article on Prussian Artillery, adding significantly—"*Voilà, mon ami*, a specimen of English scientific opinion !"

I must confess that it was not without a feeling of shame that I read an article, of which the following extracts will suffice to give a correct idea.

"Although the unchequered course of the late war was due to many causes, still it is now admitted on all sides that when the Krupp guns were brought into the field the conclusion was practically foregone." "The first public exhibition of what is now known as the Krupp gun was the gigantic specimen of a breech-loading steel gun sent to our Exhibition of 1851. The steel of which this gun was made differs entirely from our *Sheffield gun metal* or from Bessemer metal, and is a *composition invented by Krupp*, and the result of a special process. The iron is alloyed *with certain clays and also with a preparation of plumbago.* There are 100,000 '*creusets*' of this metal always in active employment in the factory, and each '*creuset*' contains from twenty to forty kilogrammes. The metal in a fluid state is poured into large cylindrical moulds, where it remains for two hours till it has completely hardened. But the chief difficulties of the process lie in subjecting it to the steam hammer. For years the hammer of greatest power in the factory had a force of 25,000 *kilometres*," &c. !

The italics are mine, and any one conversant with such subjects will perceive that no further comments are required. It only remains for me to express my astonishment at seeing such rubbish appear in the leading article of any newspaper of standing, and I am sure your readers will agree with me that it is high time that journals specially devoted to science should protest energetically against such representations being conveyed to the public at home and abroad as expressions of English technical or scientific opinion. DAVID FORBES

Boulogne-sur-Mer, September 13

THE NEW GANOID FISH (CERATODUS) RECENTLY DISCOVERED IN QUEENSLAND

AT the beginning of last year news reached Europe that a large "Amphibian resembling *Lepidosiren*" had been discovered in Australia, and the curiosity of naturalists was still more excited when it was stated that this creature was provided with teeth extremely similar to the fossil teeth (from the Jurassic and Triassic formations) known under the name of *Ceratodus*.

The interest attached to such a discovery will be easily understood, if we review briefly the history of *Lepidosiren*, and show the advance made by zoology in consequence of our acquaintance with this animal.

The discovery is due to the well-known Austrian traveller, Natterer, who sent two examples from Villa Nova on the Amazon River and the Rio Madeira to the Vienna Museum in the year 1837. Fitzinger, then Curator of the Collection of Reptiles, gave a somewhat superficial description of it under the name of *Lepidosiren paradoxa*, referring it without hesitation to the class of Reptiles. Nearly at the same time a very similar animal was found by Mr. Th. C. B. Weir, in Senegambia ; he presented two small examples to the Royal College of Surgeons ; and Prof. Owen, then Curator of the Hunterian Museum, published a full description of them under the name of *Lepidosiren annectens*, in the year 1839, explaining the reasons which induced him to regard this creature as a Fish. This view elicited further examination of the internal structure of the American species by Profs. Bischoff and Hyrtl, the former inclining to the opinion expressed by Fitzinger, the latter confirming, to the satisfaction of nearly all zoologists, the correctness of the conclusion arrived at by Owen.

Before the discovery of *Lepidosiren*, zoologists distinguished the class of Reptilia from that of Fishes by the organ of respiration, the former being provided with membranous lungs extending into the abdominal cavity, the latter breathing by gills only. Although the Batrachian reptiles were known to breathe by external gills, as fishes, during the early stage of their metamorphosis, and although some of them retain those gills through the whole period of their life, yet the development of lungs in the adult state and the co-existence of these organs with gills in the Perennibranchiates, were considered to be sufficient indications of their class-distinctness from fishes, among which no air-breathing organ was known. It is true Harvey and Hunter had pointed out that the air-bladder of the fish was homologous with the lung of higher vertebrates ; but functionally it could not be compared to it, as it receives arterial blood like any other abdominal organ, returning it in a deoxygenised condition.

Now *Lepidosiren* was found to be provided with gills, and a most perfect paired lung communicating by a ductus pneumaticus and glottis with the œsophagus, receiving venous blood by strong arteries, and sending it back directly to the heart in an oxygenised condition. Therefore, in this respect it did not differ from an Amphibian, and dogmatical believers in the stability of our zoological systems felt themselves quite justified in referring this creature to the Reptilians.

Nevertheless, the presence of certain other peculiarities of structure indicated rather an ichthyic than a reptilian affinity. The notochordal skeleton, and the apophyses arranged as in many fishes, and not as in Amphibians ; the organ of hearing enclosed in the cartilaginous capsule of the skull ; the dentition extremely similar to that of a Chimæra ; the intestinal tract traversed by a spiral valve ; peritoneal outlets near the vent ; no nasal canal to conduct air ; finally, the skin covered with scales, the fins supported by fin rays. All these are characters not found in Batrachians, and connect *Lepidosiren* with the class of Fishes ; but it was admitted that it makes the nearest approach in that class to the Perennibranchiate Amphibians.

The question had next to be settled, what place in the class of Fishes should be assigned to *Lepidosiren ;* and as the view entertained by Joh. Müller is that adopted by the majority of zoologists, we think it sufficient to refer to it alone. Having determined that all Ganoid Fishes agree with the Sharks and Rays in having an additional muscular division of the heart at the origin of the aorta, named *bulbus*

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